

WHAT IS CLAIMED IS:

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1. A method for etching a semiconductor device to form a predetermined etched pattern therein, comprising:

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- (a) providing a semiconductor device having a plurality of layers, at least one of the layers of the semiconductor device comprising a refractory metal-containing material; and
- (b) etching the semiconductor device under conditions with an etchant composition comprising a first etchant chemistry and a second etchant chemistry, providing a uniformity across the plurality of layers of  $\pm$  about 3.5 percent.

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2. The method of Claim 1, wherein the refractory metal-containing material is selected from the group consisting of refractory metals, refractory metal alloys and refractory metal silicides.

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3. The method of Claim 2, wherein the refractory metal-containing material comprises a refractory metal selected from the group consisting of molybdenum, titanium and tungsten or a refractory metal silicide selected from the group consisting of tungsten silicide and molybdenum silicide.

4. The method of Claim 2, wherein the refractory metal-containing material comprises TiW alloy.

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5. The method of Claim 1, wherein the first etchant chemistry comprises a chlorine source and a fluorine source.

6. The method of Claim 5, wherein the chlorine source is selected from the group consisting of  $\text{Cl}_2$ ,  $\text{HCl}$  and  $\text{CCl}_4$ .

7. The method of Claim 5, wherein the fluorine source is selected from the group consisting of SF<sub>6</sub>, F<sub>2</sub>, NF<sub>3</sub> and CF<sub>4</sub>.

8. The method of Claim 5, wherein the first etchant chemistry has a chlorine concentration of about 50 percent to about 95 percent.

5 9. The method of Claim 5, wherein the first etchant chemistry further comprises N<sub>2</sub>.

10. The method of Claim 1, wherein the second etchant chemistry comprises a chlorine source.

11. The method of Claim 10, wherein the chlorine source is selected from the group consisting of Cl<sub>2</sub>, HCl and CCl<sub>4</sub>.

12. The method of Claim 10, wherein the second etchant chemistry has a chlorine concentration of about 50 percent to about 95 percent.

13. The method of Claim 1, wherein the conditions include a source power of from about 100 watts to about 450 watts and a bias power of from about 200 watts to about 500 watts.

14. The method of Claim 13, wherein the ratio of the bias power to the source power is about 0.5:5.

15. A method of etching a refractory metal-containing layer and an oxide layer, the method comprising:

20 (a) etching the refractory metal-containing layer to an end point using a first etchant chemistry at a source power of from about 100 watts to about 450 watts and a bias power of from about 200 watts to about 500 watts, wherein the first etchant chemistry comprises a chlorine source and a fluorine source; and

(b) etching partially through the oxide layer using a second etchant chemistry, wherein the second etchant chemistry comprises a chlorine source.

16. The method of Claim 15, wherein the refractory metal-containing layer is disposed above the oxide layer.

5 17. The method of Claim 15, wherein the refractory metal-containing layer comprises a material selected from the group consisting of refractory metals, refractory metal alloys and refractory metal silicides.

18. The method of Claim 17, wherein the refractory metal-containing material comprises a refractory metal selected from the group consisting of molybdenum, titanium and tungsten or a refractory metal silicide selected from the group consisting of tungsten silicide and molybdenum silicide.

19. The method of Claim 17, wherein the refractory metal-containing material comprises TiW alloy.

20. The method of Claim 15, wherein the chlorine source of the first etchant chemistry is selected from the group consisting of  $\text{Cl}_2$ ,  $\text{HCl}$  and  $\text{CCl}_4$ .

21. The method of Claim 15, wherein the fluorine source of the first etchant chemistry is selected from the group consisting of  $\text{SF}_6$ ,  $\text{F}_2$ ,  $\text{NF}_3$  and  $\text{CF}_4$ .

22. The method of Claim 15, wherein the first etchant chemistry has a chlorine concentration of about 50 percent to about 95 percent.

20 23. The method of Claim 15, wherein the first etchant chemistry further comprises  $\text{N}_2$ .

24. The method of Claim 15, wherein the chlorine source of the second etchant chemistry is selected from the group consisting of  $\text{Cl}_2$ ,  $\text{HCl}$  and  $\text{CCl}_4$ .

25. The method of Claim 15, wherein the second etchant chemistry has a chlorine concentration of about 50 percent to about 95 percent.

26. The method of Claim 15, wherein the second etchant chemistry further comprises N<sub>2</sub>.

5 27. The method of Claim 15, wherein the first etchant chemistry comprises about 45 sccm of Cl<sub>2</sub>, about 30 sccm of SF<sub>6</sub> and about 5 sccm of N<sub>2</sub>.

28. The method of Claim 15, wherein the second etchant chemistry comprises about 45 sccm of Cl<sub>2</sub> and about 15 sccm of N<sub>2</sub>.

29. The method of Claim 15, wherein the source power is from about 125 watts to about 210 watts and the bias power is from about 225 watts to about 310 watts.

30. The method of Claim 15, wherein the ratio of the bias power to the source power is about 0.5:5.

31. A method of etching a semiconductor device using a capacitive coupling plasma reactor to form a predetermined pattern on the semiconductor device, comprising:

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- 15 (a) providing a semiconductor device having a plurality of layers, at least one of the layers of the semiconductor device comprising a refractory metal-containing material; and
- (b) etching the semiconductor device with an etchant composition at a bias power of from about 100 watts to about 750 watts, wherein the etchant composition comprises a first etchant chemistry and a second etchant chemistry.

20 32. The method of Claim 27, wherein the bias power is from about 250 watts to about 350 watts.

33. A method of etching a refractory metal-containing layer and an oxide layer, the method comprising:

- (a) etching the refractory metal-containing layer to an end point using a first etchant chemistry at a bias power of from about 100 watts to about 750 watts, wherein the first etchant chemistry comprises a chlorine source and a fluorine source; and
- (b) etching partially through the oxide layer using a second etchant chemistry, wherein the second etchant chemistry comprises a chlorine source.

34. The method of Claim 33, wherein the bias power is from about 250 watts to about 350 watts.

35. The method of Claim 1, wherein said refractory metal-containing layer is etched at a source power of from about 100 watts to about 450 watts and a bias power of from about 200 watts to about 500 watts.